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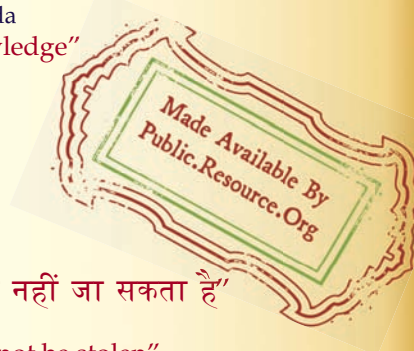
IS 4207 (1967): Leather for football [CHD 17: Leather, Tanning Materials and Allied Products]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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Indian Standard
SPECIFICATION FOR
LEATHER FOR FOOTBALL

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002



AMENDMENT NO. 1 DECEMBER 1983

TO

IS:4207-1967 SPECIFICATION FOR LEATHER FOR FOOTBALL

Alteration

[*Page 5, Table 1, Sl No. (i), col 3 to 5*] -
Substitute '*2.2*' for '*2.5*'.

(CDC 16)

Reprography Unit, ISI, New Delhi, India

Indian Standard

SPECIFICATION FOR LEATHER FOR FOOTBALL

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(Continued on page 2)

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Indian Standard

SPECIFICATION FOR LEATHER FOR FOOTBALL

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 February 1967, after the draft finalized by the Leather Sectional Committee had been approved by the Chemical Division Council.

0.2 The Sports Goods Sectional Committee, ISI, while formulating standards on sports goods, requested the Leather Sectional Committee, ISI, to take up the formulation of standards on leather for sports goods. This standard is expected to assist the tanners to offer suitable leather to the sports goods industry and to help the Sports Goods Export Promotion Council and various Quality Marking Schemes of State Governments in selecting a material of choice controlled by the conditions of national sports or the export market needs.

0.3 It has been found by experience that by treating leather with 0.1-percent sodium trichlorophenate based on its finished dry weight, it could be made effectively mildew resistant without adversely influencing the non-toxic character of the leather. Any other fungicide or a combination of fungicides which is known to be harmless to skin, in small dosages should be worked out by experiment to arrive at the optimum dosage of fungicides, so as not to cause growth of mildew.

0.3.1 Extreme caution is to be exercised since the excess dosage of fungicides is harmful which often causes chafing, irritation and even dermatitis. To arrive at the optimum dosage of effective and non-toxic fungicides, the method given in Appendix A may be followed.

0.4 The requirements prescribed in this standard are based on authentic test data on indigenous samples and those received through the courtesy of the Hungarian Government. The following laboratories took part in the inter-laboratory test scheme whose technical collaboration is gratefully acknowledged:

Central Leather Research Institute, Madras;
College of Leather Technology, Calcutta; and
National Test House, Calcutta.

0.5 This standard contains clauses 4.4 and 5.2 which call for an agreement between the purchaser and the supplier.

IS : 4207 - 1967

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements and the methods of sampling and test for leather for football produced by fullchrome tannage, chrome aluminium combination tannage or by vegetable tannage.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS: 1640-1960† shall apply.

3. TYPES

3.1 This standard covers three types of the material as follows:

- a) *Type 1* — Chrome tanned (CT),
- b) *Type 2* — Chrome aluminium tanned (CAT), and
- c) *Type 3* — Vegetable tanned (VT).

4. REQUIREMENTS

4.1 Raw Material — The material shall be cow hides.

4.2 Tanning — The material shall be tanned either by using vegetable tanning materials or their extracts with or without the use of syntans or by the chrome tanning process, or by combination of chrome and aluminium tanning materials.

4.3 Fungicide Additives — At the end of tanning operation and before drying, suitable fungicides shall be incorporated in the leather.

4.4 Finishing — The tanned leathers shall be fat-liquored or oiled or both. The leather may be dyed in brown, cream or finished white subject to the requirement of the purchaser, which shall be clearly stated while ordering. The surface shall be smooth and well set.

4.5 Physical Requirements — The material shall comply with the physical requirements given in Table 1.

*Rules for rounding off numerical values (*reviesd*).

†Glossary of terms relating to hides, skins and leather.

TABLE 1 PHYSICAL REQUIREMENTS FOR LEATHER FOR FOOTBALL

(Clause 4.5)

SL No.	CHARACTERISTIC	REQUIREMENT FOR			METHOD OF TEST, REF TO	
		Type 1	Type 2	Type 3	Appendix	Cl No. IS: 582-1954*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Thickness, mm, <i>Min</i>	2.2	2.2	2.2	—	20
ii)	Water absorption, percent by weight, <i>Max</i> :					
	a) In 0.5 h	25	25	40	—	21
	b) In 2.0 „	30	30	45		
	c) In 24.0 „	35	40	45		
iii)	Cracking strength	Grain shall not crack			—	22
iv)	Tensile strength, kg/cm ² , <i>Min</i> :					
	a) Parallel direction to backbone	210	210	210	—	23
	b) Perpendicular direction to backbone	190	190	190	—	23
v)	Elongation at 70 kg/cm ² , percent, <i>Max</i> :					
	a) Temporary	12	12	12	B	—
	b) Permanent	4	4	4		
vi)	Shrinkage temperature, °C, <i>Min</i>	95	80	77	C	—
vii)	Stitchtear strength (double hole), kg/cm thickness, <i>Min</i>	70	70	70	D	24

*Methods of sampling and test for vegetable and chrome tanned leathers.

4.6 Chemical Requirements—The material shall comply with the chemical requirements calculated on 14 percent moisture basis, given in Table 2.

4.7 Mildew Resistance—The material shall show no growth of mildew when examined visually after completion of test prescribed in Appendix F.

5. MARKING AND PACKING

5.1 The leather pieces or packages or both shall be marked with area in square decimetres and weight in kilograms, the name of the manufacturer, recognized trade-mark, type, month and year of manufacture.

5.1.1 The leather pieces or packages or both may also be marked with the ISI Certification Mark.

NOTE—The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and

TABLE 2 CHEMICAL REQUIREMENTS FOR LEATHER FOR FOOTBALL
(Clause 4.6)

SL No.	CHARACTERISTIC	REQUIREMENT FOR			METHOD OF TEST, REF TO	
		Type 1	Type 2	Type 3	Appen- dix	CI No. of IS: 582- 1954*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Total ash, percent by weight, <i>Max</i>	—	—	1.5	—	7
ii)	Oils and fats, percent by weight	2.5 (<i>Min</i>)	3.0 (<i>Min</i>)	3.0 to 8.0	—	8
iii)	Chrome content (as Cr ₃ O ₃), percent by weight, <i>Min</i>	3.0	1.5	—	—	9
iv)	Aluminium (as Al ₂ O ₃), percent by weight, <i>Min</i>	—	3.0	—	E	—
v)	Water solubles, percent by weight, <i>Max</i>	—	4.0	15	—	10
vi)	Soluble ash, percent by weight, <i>Max</i>	—	—	1.0	—	11
vii)	Insoluble ash, percent by weight, <i>Max</i>	—	—	0.5	—	12
viii)	pH of water solubles, <i>Min</i>	3.2	3.2	3.5	—	13
ix)	Differential number	—	—	0.6	—	13
x)	Degree of tannage, <i>Min</i>	—	—	55	—	17

*Methods of sampling and test for vegetable and chrome tanned leathers.

Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

5.2 The leather pieces shall be packed as agreed to between the purchaser and the supplier.

6. SAMPLING AND CRITERIA FOR CONFORMITY

6.1 Scale of Sampling — Samples for ascertaining conformity of the material shall be taken out in accordance with the procedure prescribed in IS: 582-1954*.

*Methods of sampling and test for vegetable and chrome tanned leathers.

6.2 Position of Sampling

6.2.1 Sampling Position for Chemical Tests — Sampling position for chemical analysis shall be as prescribed in IS : 582-1954*.

6.2.2 Sampling Position for Physical Tests — Sampling position for physical tests shall be as prescribed in Appendix G.

6.3 Examination for Visual Requirements — All the pieces in the sample selected from a lot shall be individually examined for each of the visual requirements, such as finish, size and shape. If any piece is found to be defective in any of the visual requirements, the entire lot shall be screened in respect of the visual requirement in order to remove all the defective pieces from the lot.

6.4 Tests for Physical Requirements — Each piece in the sample shall be tested for all the physical requirements individually. The lot shall be considered to have met the physical requirements if each piece individually satisfies every requirement; otherwise the lot shall be rejected without further testing.

6.5 Tests for Chemical and Resistance to Mould Growth Requirements — If the lot has been found satisfactory in respect of physical requirements, it shall be subjected to the tests of all other requirements of this specification. The lot shall be declared to have met the requirements of this specification if all the test results, obtained by following the specified testing procedure, satisfy the relevant requirements of this specification.

7. TEST METHODS

7.1 Carry out tests for mildew resistance, physical and chemical characteristics as prescribed in Appendix F, col 6 and 7 of Tables 1 and 2 respectively.

7.2 Standard Atmospheric Conditions for Physical Tests — Condition the test specimens to a moisture equilibrium in an atmosphere of 65 ± 2 percent relative humidity and at $27^\circ \pm 2^\circ\text{C}$ (see IS : 196-1966†) and, if possible, test in that atmosphere or soon after removal from that atmosphere.

7.3 Quality of Reagents — Unless specified otherwise, use pure chemicals and distilled water (see IS : 1070-1960‡) in tests.

NOTE - 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the test results.

*Methods of sampling and test for vegetable and chrome tanned leathers.

†Atmospheric conditions for testing (*revised*).

‡Specification for water, distilled quality (*revised*).

APPENDIX A

(Clause 0.3.1)

METHOD TO DETERMINE OPTIMUM DOSAGE OF FUNGICIDES IN TREATING LEATHER

A-1. PROCEDURE

A-1.1 Treat a 50 mm square sample successively with a standard spore suspension and observe the growth of mildew, in accordance with the method prescribed in Appendix F. At the end of the prescribed period, the sample may have the following growths of mildew as defined below:

- Vigorous* — Entire surface of leather covered with mildew in test period
Moderate — Three-fourths surface of leather covered with mildew in test period
Slight — Half of the surface of leather covered with mildew in test period
Very slight — One-fourth surface of leather covered with mildew in test period
Nil — No growth of mildew in test period

A-1.2 Treat the leather with fungicides to such an extent that no growth of mildew is just observed on the leather, the efficiency of the fungicide treatment is best judged by the performance of the treated leather following the above procedure when subjected to mildew growth test and improvement made till just no growth is obtained.

APPENDIX B

[Table 1, Sl No. (v)]

DETERMINATION OF TEMPORARY AND PERMANENT ELONGATION

B-1. TEMPORARY ELONGATION

B-1.1 Procedure — Test test-pieces cut from sample location for physical test (see **G-1.1.2**) for temporary elongation in the manner described in **23** of IS: 582-1954*. Subject the test piece to a load of 70 kg/cm². Then release the load and measure the residual increase in length after resting for 15 minutes.

B-1.1.1 Calculation — Calculate temporary elongation from the residual length expressing it as a percentage on the original length.

*Methods of sampling and test for vegetable and chrome tanned leathers.

B-2. PERMANENT ELONGATION

B-2.1 Procedure — Subject test pieces to a load of 70 kg/cm² in the manner described in 23 of IS: 582-1954*. Release the load and allow to rest for 2 and 24 hours and measure the residual length, after these periods respectively.

B-2.1.1 Calculation — Calculate the permanent elongation from the residual length, expressed as a percentage on the original length.

APPENDIX C

[Table 1, Sl No. (vi)]

TEST FOR SHRINKAGE TEMPERATURE**C-0. PRINCIPLE**

C-0.1 The thermal stability of the leather depends on the nature and extent of tannage and consequently shrinkage temperature is a direct measure of the same.

C-1. APPARATUS

C-1.1 The apparatus consists of the following essential parts.

C-1.1.1 Beaker — one litre capacity.

C-1.1.2 Clamps — two suitable clamps to hold the specimen. The upper clamp shall be capable of moving and lower clamp shall be stationary.

C-1.1.3 Heating Device

C-1.1.4 Indicating Device — An indicating device which keeps the test pieces in position and accurately detects and magnifies by at least 25 times any shrinkage or swelling of the test piece. In no case the device shall cause an elongation of more than 10 percent of the test piece prior to shrinkage.

C-1.1.5 Stirrer — a suitable mechanical stirrer.

C-1.1.6 Thermometer — a suitable thermometer reading up to 150°C.

C-2. PROCEDURE

C-2.1 Preparation of Test Piece — Cut from the relevant portion (see G-1.1.2) a test piece 10 × 60 mm.

NOTE — Decrease the sample with petroleum hydrocarbon solvent 60/80 for 24 hours at room temperature, free it from solvent and then proceed with the experiment.

*Methods of sampling and test (or vegetable and chrome tanned leathers.

C-2.2 Mount the clamps one over the other 50 mm apart, with the bottom one stationary. Attach the indicating device to the upper (moveable) clamp. Place the test piece in the clamps, completely immersed in the water at $27^{\circ} \pm 2^{\circ}\text{C}$ and allow it to remain until the water has thoroughly penetrated the test piece. Adjust the indicator to a reference (zero) point so that the eventual shrinkage may be readily detected. Stir the water while being heated at a rate of 3° to $5^{\circ}\text{C}/\text{min}$. As the temperature rises, swelling of the test piece may occur. If this happens, again adjust the indicator to the reference (zero) point. Record the temperature of the water at which the test piece begins to shrink.

APPENDIX D

[Table 1, Sl No. (vii)]

STITCHTEAR STRENGTH TEST (DOUBLE HOLE)

D-1. SCOPE

D-1.1 This method is intended for determining the stitchtear strength of the leather using a double-hole test.

D-2. APPARATUS

D-2.1 Metal Wire — a piece of soft steel wire 1 ± 0.025 mm in diameter and not less than 100 mm in length.

D-2.2 Means to Make Double Hole — a punch or other instrument for making a 2-mm hole in the test piece.

D-2.3 Testing Machine — The testing machine is similar to the machine used for testing tensile strength as prescribed in IS : 582-1954* except that the jaws of the grips of the machine should be covered with a material suitable for protecting the gripping surface from possible damage by the metal wire.

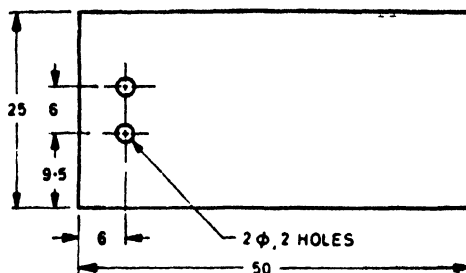
D-3. TEST PIECE

D-3.1 The test piece shall be a rectangular piece of leather 50×25 mm; cut from the test position (*see* **G-1.1.2**) of leather. The test piece shall be free from mechanical damage.

*Methods of sampling and test for vegetable and chrome tanned leathers.

D-4. PROCEDURE

D-4.1 The bent wire shall be in contact with the grain side of the test piece. Measure the thickness of the sample. Punch two holes, each 2 mm in diameter, as shown in Fig 1. Make the metal wire into U-shape loop and pass through the two holes so that both ends project from the flesh side of the test piece. Clamp the ends of the wire in the wrapped grips of the testing machine. Grip the free end of the test piece in the other grip of the machine described in **D-2.3**. Apply force to the test piece at such a rate that the actuated grip travels at a uniform speed of $25 \pm .5$ cm/min. Note the force required to tear the test piece at the moment of the initial tear.



All dimensions in millimetres.

FIG. 1 DIMENSIONS OF TEST PIECE

D-5. RESULTS

D-5.1 Test one test piece from each of the sample.

D-5.2 Average the test results obtained from the test piece tested for the double hole stitchtear strength and calculate the strength in kilograms per centimetre thickness of the sample. Record to the nearest 0.5 kg.

APPENDIX E

[Table 2, Sl No. (iv)]

ESTIMATION OF ALUMINIUM IN CHROME-ALUMINIUM TANNED LEATHER

B-1. OUTLINE OF THE METHOD

E-1.1 A known quantity of the leather is ashed. The sum of chromium and aluminium oxides in the ash is determined gravimetrically, chromium

IS : 4207 - 1967

oxide being determined separately iodimetrically. Aluminium oxide is then determined by difference.

B-2. APPARATUS

E-2.1 Platinum Crucible

E-2.2 Volumetric Flask — 200 ml capacity.

E-3. REAGENTS

E-3.1 Fusion Mixture — equal parts of anhydrous sodium carbonate, potassium carbonate and borax glass (anhydrous borax).

E-3.2 Dilute Hydrochloric Acid — 2 N.

E-3.3 Potassium Iodide Solution — 10 g of potassium iodide dissolved in 100 ml of water.

E-3.4 Sodium Thiosulphate Solution — 0.1 N.

E-3.5 Starch Solution — Triturate 5 g of pure starch and 0.01 g of mercuric iodide with 30 ml of water in a mortar. Pour the resulting paste of boiling water, boil for 3 minutes, allow the solution to cool and decant off the clear liquid.

E-3.6 Absolute Alcohol — 96 percent.

E-3.7 Ammonia Solution — sp gr 0.01.

E-4. PROCEDURE

E-4.1 Ash about 3 g of leather exactly weighed (W_1) in a platinum crucible. Mix the ash intimately with 4 to 5 times its weight of the fusion mixture and heat to a bright red heat for 1 min. Cover and allow to cool, then transfer the contents of the crucible to an agate mortar and grind intimately. Replace the mix in the crucible and roast for 10 min at a bright red heat, stirring occasionally with a platinum wire. Cover and cool. Bring the crucible in contact with about 150 ml of hot water. When all the melt is dissolved out, take out the crucible and wash it thoroughly into the beaker. Concentrate and cool the solution. Make up the solution to 200 ml in a volumetric flask. Determine chromium in 100 ml of this solution against thiosulphate iodimetrically as described in 9 of IS: 582-1954*. Acidify 50 ml of the made up solution with dilute hydrochloric acid. Reduce the hexavalent chromium to trivalent chromium by the addition of absolute alcohol. Bring the solution to boil and add ammonia solution till there is complete precipitation of combined hydroxides. Filter the precipitate through quantitative filter paper, wash

*Methods of sampling and test for vegetable and chrome tanned leathers.

with water, dry and ash the precipitate with filter paper. Ignite the residue, cool and weigh. Repeat heating, cooling and weighing till constant weight is obtained. The residue gives the combined value for aluminium and chromium as $\text{Al}_2\text{O}_3 + \text{Cr}_2\text{O}_3 (W_2)$.

E-5. CALCULATION

E-5.1 Calculate the value for aluminium by difference as follows:

a) Chromium (as Cr_2O_3), percent by weight = $\frac{V \times 2 \times 100}{W_1} = B$

where

V = volume in millilitres of 0.1-N thiosulphate solution,
and

W_1 = weight of the material in grams taken for ashing.

b) Combined chromium and aluminium
(as $\text{Cr}_2\text{O}_3 + \text{Al}_2\text{O}_3$), percent by weight = $\frac{W_2 \times 4}{W_1} \times 100 = A$

where

W_2 = weight of the residue in grams after ignition, and
 W_1 = weight of the material in grams taken for ashing.

c) Aluminium (as Al_2O_3), percent by weight = $A - B$ [see E-5.1(a) and E-5.1(b)].

APPENDIX F

(Clauses 4.7 and 7.1)

TEST FOR MILDEW RESISTANCE

F-1. OUTLINE AND SCOPE OF THE METHOD

F-1.1 Untreated leathers as well as those leathers treated with agents to mould resistance are smeared, sprayed or swabbed with mixed spore suspension of species of mould found in tanned leathers and the resistance of each leather to the growth of moulds is evaluated.

F-1.2 Conditions prescribed for sampling in this test method correspond to the conditions to which the leathers are subjected, in use and normal storage.

F-2. TEST PIECES

F-2.1 The test pieces shall be treated as follows.

F-2.1.1 The test pieces from sample (A) are kept for seven days at $45^\circ \pm 2^\circ\text{C}$ in an oven with forced air circulation and leached by

drumming for 3 hours in about 30 times their weight of water at $27^{\circ} \pm 2^{\circ}\text{C}$ (see IS : 196-1966*). The leached samples are then drained and blotted.

F-2.1.2 The second test piece from sample (B) is tested as received.

F-3. APPARATUS

F-3.1 Containers for Keeping Test Pieces — Any suitable glassware which can be conveniently stoppered, namely, jars, desiccators and glass tanks with greased covers to preclude loss of water vapour during the test may be used. The vessel may contain water at the bottom or cotton wool or clean sand previously saturated with boiling water. This is done to obtain 100 percent RH at approximately 30°C .

NOTE — The same vessel shall not be used for simultaneous testing of samples treated with different fungicides.

F-3.2 Incubators — One capable of maintaining $45^{\circ} \pm 2^{\circ}\text{C}$ with forced air circulation and another capable of maintaining $30^{\circ} \pm 2^{\circ}\text{C}$.

F-4. REAGENTS

F-4.1 Standard Mixed Spore Suspension — Standard mixed spore sand suspension of the following culture of species of moulds are to be used in the test:

Asperigillus niger
Aspergillus flavus
Asperigillus terreus
Asperigillus nidulans
Paecilomyces varioti
Penicillium frequentans

F-4.1.1 With each batch of such a suspension a list showing the organisms incorporated therein as well as the date prior to which the culture is to be used shall be furnished.

NOTE — At present only sand spore suspension of species of mould, usually found in tanned leathers, are supplied by the Central Leather Research Institute, Madras.

F-5. PROCEDURE

F-5.1 Cut four strips of 50×10 mm from the treated test pieces (see F-2.1.1), dampen with sufficient water for about 5 minutes, smear, spray or swab with mixed spore suspension and then subsequently suspend them above a free water surface in a suitable covered vessel as described in F-3.1.

F-5.2 Viability Control — Simultaneously, tests shall be carried out on test piece from control samples of leather not treated with fungicide.

*Atmospheric conditions for testing (revised).

F-5.2.1 If this untreated material fails to show any abundant growth of the test organism, the test shall be considered inconclusive and shall be repeated.

F-5.3 Incubation — Incubate the test piece for 30 days at $30^{\circ} \pm 2^{\circ}\text{C}$ and 95 to 100 percent RH in the incubator (*see F-3.2*), or relative-humidity cabinet, kept in the dark.

F-5.3.1 The test pieces shall be examined at frequent intervals, at least once a week and the date of the first appearance of mould growth shall be noted.

F-6. ASSESSMENT OF RESISTANCE TO MOULD ATTACK

F-6.1 Presence or absence of mould growth as well as the extent of growth at the end of the incubation period may be assessed visually and indicated in the test report as vigorous, moderate, slight, very slight or nil (*see A-1.1*).

F-6.1.1 The test report shall also contain the following:

- a) Number of samples tested;
- b) Nature of the samples tested, *A* or *B* (*see F-2.1*);
- c) Date of incubation; and
- d) Date of first appearance of mould growth.

APPENDIX G

(Clause 6.2.2)

SAMPLING POSITION FOR PHYSICAL TESTS

G-1. LOCATION OF PIECES FOR PHYSICAL TESTS

G-1.1 The location shall be selected from the material in the manner described in **G-1.1.1** and Fig. 2.

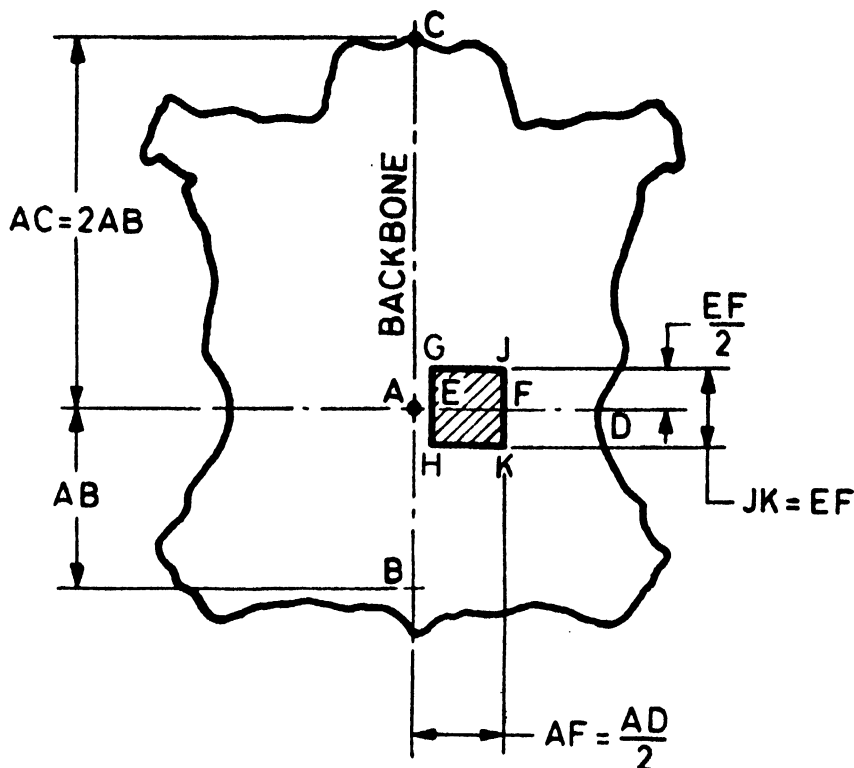


FIG. 2 SAMPLE LOCATION

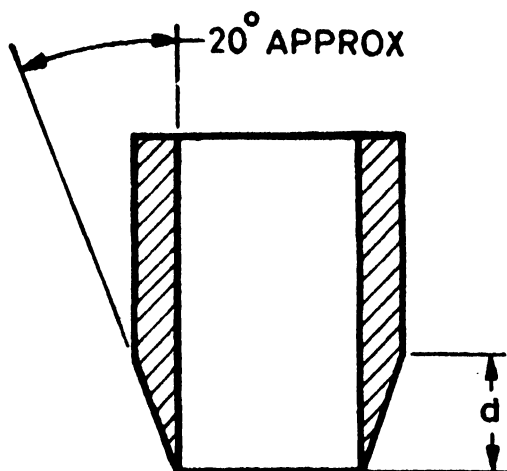
G-1.1.1 A cow hide is represented in Fig. 2 with the head portion removed. *B* is the root of the tail, *C* is the farthest point on the backbone at the neck portion. *A* is a point on the backbone such that $AC = 2AB$. *AD* is a line perpendicular to *BC*. *F* is the midpoint of *AD* and *AE* is 50 mm long. The lines *GH* and *JK*, whose midpoints are *E* and *F* respectively, are parallel to *BC* and each of length equal to *EF*.

G-1.1.2 The pieces for physical tests shall be cut from the square *HKFG*.

G-2. SAMPLE CUTTING BY PRESS KNIFE

G-2.1 The internal surface of each press knife shall be normal to the plane which contains the cutting edge. The angle formed at the cutting

edge between the internal and external surfaces of the press knife shall be approximately 20° and the wedge of this angle shall be of a depth exceeding the thickness of leather (*see* Fig. 3).



d = DEPTH OF THE WEDGE

FIG. 3 SHAPE OF PRESS KNIFE

G-2.2 Method of Gutting Sample — In cutting the samples, the knife shall be applied to the grain surface. To obtain clean-cut sample pieces for physical tests, the press knife used shall be sharp. It is advantageous to place a thick sheet of paper between the sample and the cutting board.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition</i>
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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